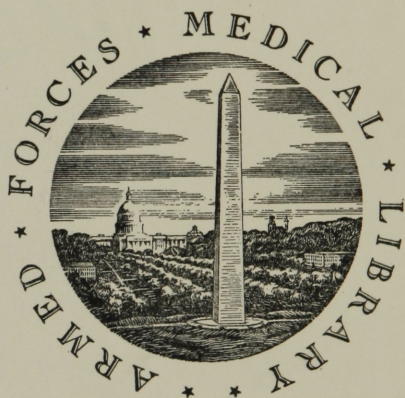




UNITED STATES OF AMERICA



FOUNDED 1836

---

WASHINGTON, D.C.









R<sup>ce</sup> 1819. A N

INAUGURAL DISSERTATION

ON THE

Chemical Properties of Atmospheric Air:

SUBMITTED TO THE EXAMINATION OF THE

REV. JOHN EWING, S. T. P. *PROVOST*,

T H E

TRUSTEES AND MEDICAL PROFESSORS

OF THE

UNIVERSITY OF PENNSYLVANIA:

FOR A DEGREE OF DOCTOR OF MEDICINE, ON THE  
TWELFTH DAY OF MAY, 1791.

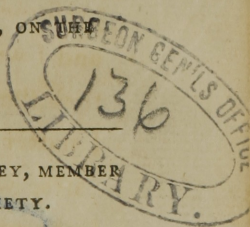
BY WILLIAM R. COZENS, OF NEW-JERSEY, MEMBER  
OF THE PHILADELPHIA MEDICAL SOCIETY.

"Phoebe, fave novus ingreditur tua templa sacerdos."

P H I L A D E L P H I A :

PRINTED BY T. DOBSON, AT THE *STONE HOUSE*,  
IN SECOND STREET.

M, DCC, XCI.



JONATHAN KILMER, M.D.

The Rev. ANDREW HUNTER, A.M.

# DISSERTATION

WITH ALL THE DEFERENCE

AND RESPECT,

BY JOHN WOOD, M.D.

RECTOR AND FELLOW,

OF THE UNIVERSITY OF OXFORD.

IN ANSWER TO A QUESTION

THE AUTHOR

OF THE UNIVERSITY OF OXFORD, AND

OF THE UNIVERSITY OF CAMBRIDGE.

PRINTED BY J. B. BARNARD, ST. MARTIN'S LANE.

A 2

1794. 4s. 6d. per copy.

Printed by J. B. BARNARD, ST. MARTIN'S LANE.

in the Year 1794.

in the Year 1794.

T O

JONATHAN ELMER, M.D.

A N D

THE REV. ANDREW HUNTER, A.M.

T H I S

DISSERTATION

IS INSCRIBED,

WITH ALL DUE DEFERENCE

AND RESPECT,

BY THEIR MUCH OBLIGED

FRIEND AND PUPIL,

THE AUTHOR.

A 2



JONATHAN ELMER, M.D.

P R I N T E D A N D C O .

THE REV. ANDREW HUNTER, A.M.

THE BOOK OF THE HISTORY OF THE  
Tribes of Israel, &c. &c. &c.THIS BOOK, HAVING BEEN  
RECEIVED BY THE  
DISSEMINATIONOF MEDICINE, IS INSCRIBED,  
TO THE LIBRARY OF THE  
AND OPINION

WITH ALL DUE DEFERENCE

FARMLEY, CO. AND RESPECT,

CONSIDERED THE BY THEIR MUCH OBLIGED

ALL SUCH PRODUCTIONS, FRIEND AND TUTOR,

THAT ALMOST EVERY, &amp;c. &amp;c. &amp;c.

PEOPLE OF DIFFERENT NATIONS, &amp;c. &amp;c. &amp;c.

THE VARIOUS NATIONS OF THE AUTHOR,

CIRCUMSTANCES, &amp;c. &amp;c. &amp;c.

UNKNOWN, I HAVE CHOSEN IT AS A SUBJECT FOR

COMMUNICATION, &amp;c. &amp;c. &amp;c.

WHICH I HAVE THE A. &amp;c. &amp;c. &amp;c.

AN HONORABLE, &amp;c. &amp;c. &amp;c.

A FIDELITY, &amp;c. &amp;c. &amp;c.

FROM THE IMPRESSION OF THE

---

## P R E F A C E.

THE laws of the University of Pennsylvania respecting a Medical Education, have required among other things, that every candidate for a degree of Doctor of Medicine, shall publish a Thesis, written in the Latin or English language, at his own option.

FORMERLY the Latin language was considered the most proper medium for all such productions, as it was expected that almost every essay would be read by people of different nations. But as I have not the vanity to think that this Thesis will circulate where the English language is unknown, I have chosen it as a vehicle to communicate my ideas to the world, for which I have the authority of many eminent literary characters, which I hope will be a sufficient excuse for, and screen me from, the imputation of singularity.





A N

INAUGURAL DISSERTATION.

THE preservation of our health, and the cure of diseases, as well as the explanation of many chemical processes, being so much influenced by an accurate knowledge of the chemical properties of the atmosphere, as also of inflammable and fixed air, called by M. Lavoisier hydrogen and carbonic acid gas, I consider sufficiently apologies for my making the investigation of them the subject of an inaugural dissertation; in which, if I differ from the most common received opinion, I hope I shall be excused for pursuing that which appears to me best established by facts and experiments. And if I should not be able to add to the present knowledge of the subject, so far exhausted by the intense labours of so many eminent authors, I hope my well meant endeavour will not be

be construed into presumption. Under these considerations, I shall proceed with the utmost diffidence to arrange the subject under different Sections.

SECT. 1<sup>st</sup>. I shall make some observations on the atmosphere, and its component parts. 2<sup>d</sup>. I shall endeavour to explain the nature and properties of hydrogen gas. 3<sup>d</sup>. I shall treat of carbonic acid gas.

## S E C T. I.

*Observations on the atmosphere and its component parts.*

THE atmosphere, which encircles our globe, and which we breathe, was formerly considered to be a simple homogeneous mass; but by the investigation and experiments of philosophers, it has been discovered to consist of two kinds of air, essentially different from each other, each of which may be easily obtained in a separate state by many artificial as well as by many natural processes; and when analysed, are supposed

supposed by many to be simple elementary bodies. But it is now clearly demonstrated by chemical analyses, that all aeriform fluids are compound bodies, composed of a base more or less solid, united with a certain subtle penetrating substance, supposed to be the matter of heat or elementary fire, called by M. Lavoisier, *caloric*: That caloric, when combined with the base, keeps it in a state of solution, and reduces it into the form of vapour or elastic fluid, in which state it possesses the common properties of air: That these component parts may be decomposed and separated from each other by combination with other bodies; and when thus decomposed, are found to possess properties very different from those they possessed in a state of combination. The different airs composing the atmosphere, are pure and mephitic air, called by M. Lavoisier, oxygen and azotic gas, which are always found to exist formally in it; and which are commonly combined in the proportion of twenty-seven parts of oxygen gas and seventy-three of azotic gas in an hundred parts of atmospheric air. This proportion, however, is found to vary in

B
different



different states of the atmosphere; by a knowledge of which at any given time, and the properties of these airs in a separate state, we readily ascertain the particular properties of the atmosphere at that time, which in a great measure influences animal health according as it is more or less pure, which depends on its superabounding either with oxygen or azotic gas.

THAT component part of the atmosphere, called by Mr Lavoisier *oxygen gas*, is proven by the experiments of philosophers to be composed of a peculiar base combined with caloric, or the matter of heat which keeps it in its aeriform state, and is the only fluid capable of supporting combustion and the respiration of animals; which is proven from its being three times as effectual as atmospheric air in these processes; that is to say, an animal will breath three times as long in it as in common atmospheric air, and a body which requires four cubic inches of atmospheric air to be entirely burnt, will require no more than one cubic inch of it for the same purpose; which is also a proof, that the oxygen gas

con-

contained in the atmosphere in its common state, does not exceed the proportion of one-fourth of the common mass. In the process of combustion the oxygen gas is decomposed, the caloric or matter of fire being separated and dissipated, while the base unites and becomes fixed in the body which is burned ; and in this manner the whole theory of combustion is explained by those who deny the existence of phlogiston, or the principle of inflammability in bodies. The property and proportion of oxygen gas in the atmosphere, clearly explains why only about one-fourth of a given quantity of common atmospheric air is absorbed during combustion, and why the process of combustion is effected more slowly, and with the disengagement of a less quantity of light and heat in atmospheric air than in oxygen gas ; and also why air, which has served the purposes of combustion and animal respiration, will no longer support animal life or maintain combustion. This kind of air is possessed of some more of the properties of common atmospheric air in an eminent degree, besides those which have been mentioned ; it exceeds it a little in its specific gravity



gravity, the proportion between it and common atmospheric air being that of 168 to 152. On introducing a lighted candle into it, the flame not only grows larger but becomes exceedingly bright, and when it is very pure the candle burns with a decrepitation as if it contained some combustible matter, at the same time the wax or tallow wastes in a surprising manner; the heat of the flame is in proportion to the light. If we fill a bladder of oxygen gas, and then fasten to its neck a glass tube, whose aperture is drawn to a fine point, the fluid if driven out by pressing the bladder, will augment the heat of the candle to such a degree, that if any small pieces of metal placed on a bit of charcoal be held in the apex of the flame, they will be almost instantly fused, even platina may by this means be fused; and in a large fire there is no doubt that the effects of burning mirrors might be equalled. Oxygen, or the basis of oxygen gas, constitutes one of the component parts of all acid bodies, from which property it has derived its appellation; and the difference observeable in acids is supposed to depend entirely on the different kinds of mat-

ter



ter with which this principle is combined in forming those acids. Oxygen combined with metals by means of heat or any other way, destroys their metallic quality, and converts them into calces, which equals the weight of the metal employed, and elastic fluid absorbed in the process; which satisfactorily proves that the calcination of these substances does not depend upon the separation of a substance, but upon the addition of oxygen gas, as the weight is increased; and what further corroborates this opinion is, that they may be again reduced to their metallic form by separating this basis from them. But the most curious and extraordinary property of this aerial basis is, that it constitutes one of the component parts of common water; for if it be united with hydrogen by combustion, in the proportion of 85 parts of oxygen to 15 parts of hydrogen, common water will be produced, equal in weight to the two aerial fluids employed in the process. This theory is farther corroborated from obtaining hydrogen gas by decomposing water, by passing it through an iron tube, heated red hot at one end, and kept cool at the other, for the purpose

pose of applying a bladder, in which the hydrogen gas will be collected, and the oxygen gas will be absorbed by the metal in the inside of the tube, which will be found calcined. Many of the processes of nature and art alter the state of the atmosphere, by encreasing or by diminishing the proportion of oxygen gas in it. Thus (as has already been shown) the combustion of all inflammable bodies, and the respiration of animals, by the absorption of the oxygen continually diminishing its quantity in a given proportion of the atmosphere, gradually rendering it effete and unfit for farther respiration and combustion, as happens frequently in crowded gaols, hospitals and ships. On the contrary, other bodies, as the leaves of vegetables when acted upon by the rays of the sun, possess the property of decomposing water; and the hydrogen gas being absorbed by the leaves, the oxygen which entered into the composition of the water is disengaged, and thereby renews and purifies the atmosphere, and in this manner it is, that the proper proportion of the atmospheric air is kept up by vegetation. Thus we see, that one kingdom

dom affords the principle of existence to the other, and death to itself. Hence it clearly appears, that if benign Nature had not provided for the preservation of this equilibrium, both must soon have perished.

Azotic gas, as observed above, is one of the component parts of the atmosphere, into the composition of which it enters in the proportion of 73 of azotic gas to twenty-seven parts of Oxygen gas in an hundred parts of atmospheric air. It is considered as a compound body, as well as all the others composed of a peculiar base, called by Lavoisier, *azote*; from whence its name, combined with caloric, which fuses and reduces it to its aeriform elastic state, in which it exists ready formed in the atmosphere, and is developed in proportion as the oxygen gas is absorbed or dissipated by combustion or animal respiration. This was proved by an experiment of M. Lavoisier, who introduced four ounces of mercury to fifty cubic inches of common air; who proposed to calcine the metal by keeping it twelve days in a heat almost equal to that which is necessary to make it boil: after the expiration  
of



of the appointed time, forty five grains of the precipitate per se were formed, and the air in the vessel was diminished by about one-sixth of its volume. In this state it instantly extinguished candles, and killed animals immersed in it, and it did not precipitate lime water; which contradicts the opinion of those philosophers who suppose, that in the act of combustion phlogiston is admitted into the air, which uniting with it, forms the aerial acid which renders it noxious to animals and unfit for combustion. On distilling the precipitate produced, about as much oxygen gas was obtained as had been lost by the common air in the calcination, and by recombining this with the noxious air left in the vessel, he reproduced a fluid nearly of the same quality as common atmospheric air. Hence he draws the following conclusions; first, that five-sixths of the air we breathe is incapable of supporting the respiration of animals, or the combustion of inflammable bodies. Secondly, that the surplus, or only one-sixth of the volume of atmospheric air, is respirable. Thirdly, that in the calcination of mercury this metallic substance

stance absorbs the salubrious parts, leaving only the noxious portion. Fourthly, That by reuniting those two portions we can reproduce air similar to that of the atmosphere. Many important discoveries have lately been made respecting the nature of this air. Its weight to that of the atmospheric air is as 985 to 1000; and by experiments it is proven, that three parts of it, and seven parts of oxygen gas, exposed to the action of electric fluid, produces the nitrous acid: this discovery clearly explains the theory of the formation of the nitrous acid in the atmosphere, and the remarkable fulminating properties of that singular fluid; when combined in the proportion of five parts of it with one part of hydrogen gas, it forms volatile alkali, as all animal and some vegetable substances contain azotic gas; it is in consequence of this combination, effected by the action of fire or putrefaction, that volatile alkali is obtained from them. Neither water, earth, nor acids, have any sensible action on this air. These remarkable properties of azotic gas, are more particularly entitled to the attention of physicians, as they throw great

light on the medical properties of air, discover the cause of its salubrious and noxious effects in certain circumstances, explains the nature of animal and vegetable substances, the formation of volatile alkali, the production of nitrous acid, and the natural process of putrefaction. Various methods are employed for procuring it in a separate state. The most usual process consists in exposing *hepar sulphuris* in a liquid state, to a given quantity of atmospheric air under a glass vessel; the liver by degrees absorbs the oxygen gas, leaving the azotic gas behind. The process of combustion, as was shewn above, will also decompose the atmospheric air by absorbing the salubrious part, and leaving the noxious portion behind. This accounts for the suffocation and death of animals which soon follow from burning charcoal or other combustible matter in a close room. All writers, until very lately, confounded this fluid with carbonic acid gas; but it is easily distinguished from it, by being specifically lighter, by having no sensible smell or taste, by not changing the colour of vegetable blues, and by occasioning no precipitation

with



with lime water ; the reverse of all which being the properties of carbonic acid gas.

## S E C T. II.

*An explanation of the nature and properties of hydrogen gas.*

HYDROGEN gas is a discovery of much later date than either of the former ; the properties of which it is possessed, are equally singular with those we have already mentioned. It is the lightest of all the aeriform fluids, which property hath lately rendered it famous for the construction of air balloons, by the assistance of which men are possessed of the power of traversing, and investigating the superior regions of the atmosphere, which before seemed denied them by nature. According to Cavendish, by whom its greatest rarity was first ascertained in the year 1766, it exceeds common atmospheric air in levity in the ratio of twelve to one, which causes it continually to tend upwards, and which explains the impurity of the atmosphere, on high mountains

mountains and other elevations. By itself it extinguishes flame, and kills animals, but in contact with common atmospheric air, or oxygen gas, it is highly inflammable; which may be proved by applying a lighted candle to the surface of stagnant waters, in which animal or vegetable substances have putrefied after agitation, from which this fluid will immediately take fire, and afford a curious appearance, which clearly explains the nature of that phenomenon called *ignis fatuus*, which is nothing more than hydrogen gas, (produced in the same manner and elevated in the atmosphere), set on fire by electricity which continues to burn until the whole is consumed. To this cause some have attributed many luminous appearances in the air, such as weak flashes of lightning, *aurora borealis*, and the like; but these appear to be more rationally accounted for from electricity alone. But the most remarkable properties of which it is possessed, is, that it constitutes one of the component parts of common water, which is proved by exploding fifteen parts of hydrogen gas by the electric spark in eighty five parts of oxygen gas,

gas, which it will absorb during combustion, and common water will be produced equal in weight to both gases employed. From this cause an eminent author conjectures, that those showers which we observe to succeed thunder and lightning in the summer season originate. He says, “ Why may not those showers which are  
 “ accompanied with thunder and lightening arise from hydrogen gas, exploded  
 “ in the superior regions of the atmosphere by electricity, and therefore changed into water ?” As water is composed of hydrogen and oxygen united, all substances which have a greater attraction with one of these two principles of water than they have with each other, will decompose this fluid ; hence iron and zinc are found to decompose water, because these bodies have a greater attraction for oxygen gas, than this has for hydrogen gas ; consequently, that which enters into the composition of water will separate from the hydrogen gas, and unite with those bodies. This fluid is produced in great quantities from the putrefaction of animal and vegetable



table substances in stagnant water, and from various processes both natural and artificial.

### S E C T. III.

#### *Remarks on the nature and properties of carbonic acid gas.*

THE discovery of this fluid is as ancient as Van Helmont, who called it gas sylvestris, from its being emitted in large quantities from burning charcoal. But its composition and mode of production has been reserved for the discovery of the famous Lavoisier, who has demonstrated that it is formed from charcoal, combined with oxygen gas, in the act of combustion; from which he has called it carbonic acid, which when fused and reduced to an elastic aeriform state by combination with caloric, constitutes carbonic acid gas, which is specifically heavier than any other permanently elastic fluid, being about one-third heavier than common atmospheric air, from which it differs in many other properties,

properties, as well as from all other aëri-form fluids, to wit, by possessing the specific property of acids, such as turning vegetable blues red, and being acidulous to the taste, from which it is reckoned among the number of acid bodies. It renders caustic alkalies mild, by combining with them, which clearly explains the cause of the effervescence produced by their union with acids. It precipitates lime dissolved in water, by decomposing the solution, by combining with the lime which causes it to fall to the bottom. It kills animals, extinguishes flame, which explains the cause of damps found in subterraneous caverns, and it has a considerable antiseptic power, and will check the putrefaction of animal substances, from which property an eminent physician has recommended it very rationally in diseases, of the alimentary canal, tending to putrefaction, by way of glister. Lastly, it is readily absorbed by water, with which, it forms the mineral waters called acidulous.

AFTER closing this subject, I cannot lay down my pen without embracing this favourable opportunity of publicly returning

ing

ing my most sincere thanks to our worthy preceptor, Doctor James Hutchinson, professor of Chemistry and Materia Medica in the University of Pennsylvania, for the most disinterested friendship and innumerable favours which I experienced from him during my studies in this seminary; and of acknowledging the infinite advantages I have received from his ingenious observations and accurate experiments, in acquiring the knowledge of those branches which he taught.

F I N I S.







Med. Hist.

WZ

270

C882i

1791

C.1



